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(54) Title: METHODS OF USE OF THE TACI/TACI-L INTERACTION

(57) Abstract

The invention discloses a novel interaction between a TNF receptor (TACI) and its interacting ligand (TACI-L). Also disclosed are methods of screening candidate molecules to determine potential antagonists and agonists of the TACI/TACI-L interaction. The use of the antagonists and agonists as therapeutics to treat autoimmune diseases, inflammation, and to inhibit graft vs. host rejections is further disclosed.

METHODS OF USE OF THE TACI/TACI-L INTERACTION

5   **FIELD OF INVENTION**

This invention relates generally to the interaction between the transmembrane
activator and CAML-interactor (TACI) protein and its ligand, TACI ligand (TACI-L),
use of the interaction in screening assays thereof, and related kits.

10

BACKGROUND OF THE INVENTION

Cellular change is often triggered by the binding of an extrinsic element, such as a
ligand, to the extracellular domain of a cell surface membrane receptor protein. This
15   binding can result in cellular changes by activating and controlling intracellular signaling
cascades and cell regulatory mechanisms. As such, understanding the initial binding
interaction between the ligand and its receptor protein can be of great interest to the
scientific community. A greater understanding of this interaction would enable one
skilled in the art to modulate the resulting signaling cascade governed by the
20   ligand/receptor interaction by selecting agents for co-stimulation or inhibition of the
binding of the ligand to its receptor.

The tumor necrosis factor (TNF) receptor family is a class of mammalian
signaling molecules that play an important role in protection against infection and
immune inflammatory responses such as cellular signal transduction, stimulation of cells
25   to secrete cytokines, cytotoxic T cell proliferation, general cellular proliferation, lymph
node formation, bone formation, and bone degradation. TNF-mediated cellular signaling
often involves a molecular activation cascade, during which a receptor triggers a ligand-
receptor mediated signal. Alterations in TNF activation can have profound effects on a
multitude of cellular processes, such as the activation or inhibition of cell-specific
30   responses, cell proliferation, inflammatory reactions, and cell death.

The interactions between TNF ligands and receptors may result in one-directional
signaling (the interaction of the TNF receptor/ligand triggers a signaling cascade in the
receptor only) or may result in bi-directional or reverse signaling. In the instances of bi-
directional or reverse signaling, the interaction would not only activate the signaling

cascade of the TNF receptor but would also trigger a signaling cascade in a cell bearing the TNF ligand. (S. Wiley et al., *Jour. of Immun.*, 3235-39 (1996).) Thus, understanding the interaction between a TNF receptor and ligand may result in therapeutic treatments involving the inhibition or enhancement of either one or both of the TNF receptor activity

5   or TNF ligand activity.

One member of the TNF receptor family is the transmembrane activator and CAML-interactor (TACI), a cell surface protein. The TACI protein has been isolated and is described in WO 98/39361. When activated, TACI stimulates the influx of calcium in lymphocytes and initiates the activation of a transcription factor through a combination of

10   a Ca^{2+}-dependent pathway and a Ca^{2+}-independent pathway. Functions of TACI include controlling the response of lymphocytes to cancer and to foreign antigens in infections, graft rejection, and graft-vs.-host disease (GVHD). Furthermore, activation of lymphocyte signaling allows the positive selection of functional lymphocytes and negative selection against self-reactive clones. (WO 98/39361 at 15.)

15   TACI modulated signals are often activated by a extracellular ligand/receptor interaction, which then triggers an intracellular protein/protein interaction. One of the intracellular proteins which bind with the TACI protein has been identified. TACI interacts with the calcium-signal modulating cyclophilin ligand (CAML), a protein associated with the calcium pathway in lymphocytes. According to WO 98/39361, after

20   the binding of the extracellular domain of TACI to an extracellular ligand, the cytoplasmic domain of TACI binds CAML, initiating a Ca^{2+}-dependent activation pathway, which includes the activation of the transcription factors, NF-AT, AP-1 and NF_xB, a factor implicated in the actions of other members of the TNF-receptor family. The regions for the interaction between TACI and CAML were defined as the

25   cytoplasmic COOH-terminal 126 amino acids of TACI and the NH_2-terminal 201 amino acids of CAML. CAML's ability to act as a signaling intermediate was verified by the inhibition of TACI-induced activation of the transcription factor when blocked by a dominant-negative mutant. (Von Bülow, G. et al., *Science*, Vol. 278, p.138-141 (1997).)

Although this interaction between the cytoplasmic domain of TACI and CAML

30   has been identified, little is known about the extracellular ligand with which TACI interacts to initiate the intracellular cascades. Given the important role TACI plays in signal transduction and given the potential therapies that may arise from the manipulation of the signaling cascades, there is a need in the art for the identification and understanding of the interaction of TACI with its signaling ligand. Further, there is a

need for the development of assays and therapeutic methods using the interaction between TACI and its signaling ligand.

Another TNF protein that has been recently discovered is a ligand that has been designated Neutrokine α, which is described in WO 98/18921. Identical nucleotide and
5   polypeptide sequences have also been disclosed as "TL5" in EP 0869180A1 and as "63954" in WO 98/27114. As a member of the TNF family, Neutrokine α polypeptides were described as useful in the treatment of tumor and tumor metastasis, infections by bacteria, virus and other parasites, immunodeficiencies, inflammatory disease, lymphadenopathy, autoimmune diseases, and GVHD. Neutrokine α was also described
10   as useful to mediate cell activation and proliferation. Further, Neutrokine α polypeptides were described as primary mediators of immune regulation and inflammatory response. (WO 98/18921 at 11; EP 0869180A1 at 3.)

As Neutrokine α polypeptides may inhibit immune cell functions, the ligand was described as also having a variety of anti-inflammatory activities. (WO 98/18921 at 49.)
15   Specifically, it was said that Neutrokine α polypeptides could be used as an anti-neovascularizing agent to treat solid tumors and for other non-cancer indications in which blood vessel proliferation is not wanted. (Id.) The polypeptides could also be employed to enhance host defenses against resistant chronic and acute infections and to inhibit T-cell proliferation by the inhibition of IL-2 biosynthesis. Finally, Neutrokine α
20   polypeptides could also be used to stimulate wound healing and to treat other fibrotic disorders. (Id.)

As such activities may be modulated by the Neutrokine α polypeptides, knowledge of how the ligand functions would be of significant interest to the scientific community. WO 98/18921, EP 0869180A1 and WO 98/27114, however, fail to identify
25   specific receptors with which Neutrokine α polypeptides bind. Identification of the related TNF receptor would allow those skilled in the art to identify antagonists which may then be used in therapies to treat the disorders associated with the Neutrokine α polypeptides. Thus, there is a need to greater understand this TNF ligand, identify the receptors with which it interacts, and determine how the interaction functions.

SUMMARY OF THE INVENTION

This invention aids in fulfilling these needs in the art by identifying a novel interaction between the extracellular domain of TACI and the Neutrokine α polypeptide

5   (hereinafter referred to as TACI ligand (TACI-L)), and uses thereof. Specifically, the invention encompasses the identification of a novel interaction between TACI (SEQ. ID. NO.: 2) and TACI-L (SEQ. ID. NO.: 4).

The present invention provides for screening assays amenable to high throughput screening of chemical libraries and suitable for the identification of small molecule drug

10   candidates, antibodies, peptides and other antagonists and/ or agonists. The present invention includes screening methods for identifying molecules that enhance or inhibit the TACI/TACI-L interaction, or that prevent or inhibit dissociation of a complex formed by TACI and TACI-L.

In one embodiment of the present invention, the screening method involves

15   contacting a mixture of cells which express TACI and cells which express TACI-L with a candidate molecule, measuring cellular responses, and detecting the ability of the candidate molecule to inhibit or enhance the interaction between TACI and TACI-L or inhibit the dissociation of the complex formed by TACI and TACI-L. Successful inhibition indicates that the candidate molecule is an antagonist. Increased activation of

20   TACI or TACI-L indicates that the candidate molecule is an agonist. The candidate molecules are preferably small molecules, antibodies or peptides.

In a further aspect of the present invention, a solid phase method may be used to identify small molecules that inhibit the interaction between TACI and TACI-L. Using this method, TACI may be bound and is placed in a mixture with labeled TACI-L. After

25   contact, the amount of signal is measured. Diminished levels of signal indicate that the candidate molecule inhibited the interaction between TACI and TACI-L.

In a still further aspect, the present invention provides a screening method for identifying molecules that mimic the biological activity of the TACI/TACI-L interaction. This screening method involves adding a candidate molecule that binds to TACI or

30   TACI-L to a biological assay and comparing the biological effect of the candidate molecule to the biological effect of TACI/TACI-L complex.

In yet a further aspect, the invention provides for a therapeutic use of agonists and antagonists of the TACI/TACI-L complex in the treatment of diseases modulated by the complex.

In still a further aspect, the invention provides for the antagonists and agonists of the TACI/TACI-L complex.

Finally, the invention relates to a kit to aid in the above determinations and uses.

5   **BRIEF DESCRIPTION OF THE FIGURES**

FIG. 1 shows the nucleotide (SEQ. ID. NO.:1) (FIG. 1a) and deduced amino acid (SEQ. ID. NO.:2)(FIG. 1b) sequences of the TACI protein.

FIG. 2 shows the nucleotide (SEQ. ID. NO.:3) (FIG. 2a) and deduced amino acid

10   (SEQ. ID. NO.:4)(FIG. 2b) sequences of the TACI-L protein.

FIG. 3 shows the amino acid sequence of a polypeptide (SEQ. ID. NO.:5), in which a CMV leader followed by a leucine zipper motif is fused to the N-terminal region of the amino acid sequence of TACI-L.

FIG. 4 shows the results of a plate binding assay capturing TACI-L in which the

15   ligand is diluted 1:2. FIG. 4a demonstrates the results of the assay and shows the complete saturation of the receptor binding sites. FIG. 4b, the Scatchard plot corresponding to FIG. 4a, demonstrates the actual number of sites that were bound. From these results, an affinity constant of 1.53×10^{-9} can be generated.

FIG. 5 shows the results of a plate binding assay capturing TACI-L in which the

20   ligand is diluted 1:5. FIG. 5a demonstrates the results of the assay and shows the complete saturation of the receptor binding sites. FIG. 5b, the Scatchard plot corresponding to Figure 5a, demonstrates the actual number of sites that were bound. From these results, an affinity constant of 2.2×10^{-9} can be generated.

FIG. 6 shows the results of a plate binding assay capturing HuTACI/Fc. FIG. 6a

25   graphs the complete saturation of the receptor binding sites. FIG. 6b, the Scatchard graph which corresponds to FIG. 6a, demonstrates the actual number of sites that were bound. The Scatchard plot of FIG. 6b demonstrates a curvilinear binding, with a low affinity constant of 5.7×10^{-10} and a high affinity constant of 1.0×10^{-10}.

FIG.7 illustrates a homogeneous time-resolved fluorescence energy transfer assay.

30   FIG 7a demonstrates that if binding occurs in the assay, the system may be excited with light at 340 nm, causing europium chelate label to emit light at 615 nm. This excites the APC, which in turn emits at 665 nm. FIG 7b demonstrates that the presence of an inhibitor of the TACI/TACI-L complex results in the diminution of the signal emitted by the APC

DETAILED DESCRIPTION OF THE INVENTION

The terms "TACI" and "TACI protein" are used interchangeably to define the TNF receptor disclosed by WO 98/39361. TACI comprises an extracellular domain, a

5   transmembrane domain, and a cytoplasmic domain.

"Fragments" of TACI encompass truncated amino acid sequences of the TACI protein that retain the biological ability to bind to TACI-L. An example of such a fragment is the extracellular domain of TACI. Such fragments are identified in WO 98/39361, which is incorporated in this application in its entirety.

10   "Soluble TACI" includes truncated proteins that lack a functional transmembrane domain of the protein but retain the biological activity of binding to TACI-L. The soluble, extracellular domain can be used to inhibit cellular activation.

"Homologous analogs" of TACI include isolated nucleic acids of the TACI protein that are at least about 75% identical to SEQ.ID.NO.:1 and retain the biological

15   activity of binding to TACI-L. Also contemplated by the term are embodiments in which a nucleic acid molecule comprises a sequence that is at least 80% identical, at least 90% identical, at least 95% identical, at least 98% identical, at least 99% identical, or at least 99.9% identical to SEQ.ID.NO.:1 and retain the biological activity of binding to TACI-L. Further included are nucleic acids which are at least 85% similar, at least 95% similar, or

20   at least 99% similar to nucleic acids that encode the amino acids of the TACI protein, as described in SEQ. ID. NO.:2, and that maintain a binding affinity to TACI-L. Still further included are all substantially homologous analogs and allelic variations.

The percent identity and percent similar may be determined by visual inspection and mathematical calculation. Alternatively, the percent identity of two nucleic acid

25   molecules can be determined by comparing their sequences using the GAP computer program, version 6.0 described by Devereux et al. (*Nucl. Acids Res.* 12:387, 1984) and available from the University of Wisconsin Genetics Computer Group (UWGCG). The preferred default parameters for the GAP program include: (1) a unary comparison matrix (containing a value of 1 for identities and 0 for non-identities), and the weighted

30   comparison matrix of Gribskov and Burgess, *Nucl. Acids Res. 14*:6745, 1986, as described by Schwartz and Dayhoff, eds., *Atlas of Protein Sequence and Structure*, National Biomedical Research Foundation, pp. 353-358, 1979; (2) a penalty of 3.0 for each gap and an additional 0.10 penalty for each symbol in each gap; and (3) no penalty

for end gaps. Other programs used by one skilled in the art of sequence comparison may also be used.

The terms "TACI-L" and "TACI ligand" are used interchangeably to define the member of the TNF ligand family disclosed by WO 98/18921. TACI-L is also disclosed

5   as "TL5" in EP 0869180A1 and as "63954" in WO 98/27114. The full-length TACI-L comprises an extracellular domain, a transmembrane domain, and a cytoplasmic domain. Although the exact location of the extracellular, transmembrane, and cytoplasmic domains may differ slightly due to different analytical criteria for identifying the functional domains, the range of amino acids 1 to 46 generally represents the intracellular

10   domain; amino acids 47 to 72 represent the transmembrane domain, and amino acids 73-285, the extracellular domain.

"Fragments" of TACI-L encompass truncated amino acids of the TACI-L protein that retain the biological ability to bind to TACI. An example of such a fragment is the extracellular domain of TACI-L, which binds TACI.   Another example of a TACI-L

15   fragment is amino acids 123–285 of the extracellular domain of the TACI ligand.

"Soluble TACI-L" includes truncated proteins that lack a functional transmembrane domain of the protein but retain the biological activity of binding to TACI. The soluble, extracellular domain can be used to inhibit cellular activation.

"Homologous analogs" of TACI-L include isolated nucleic acids of the TACI-L

20   protein that are at least about 75% identical to SEQ.ID.NO.:3 and retain the biological ability to bind to TACI. Also contemplated by the term are embodiments in which a nucleic acid molecule comprises a sequence that is at least 80% identical, at least 90% identical, at least 95% identical, at least 98% identical, at least 99% identical, or at least 99.9% identical to SEQ.ID.NO.:3 and retain the biological ability to bind to TACI.

25   Further included are nucleic acids which are at least 85% similar, at least 95% similar, or at least 99% similar to nucleic acids that encode the amino acids of TACI-L, as described in SEQ. ID. NO.:4 and that maintain a binding affinity to TACI. Still further included are all substantially homologous analogs and allelic variations.

Sequences are substantially homologous when at least 50% (preferably 60%,

30   more preferably 65%, more preferably 75%, more preferably 85%, and most preferably 99%) of the nucleotides match over the defined length of the DNA sequences. Sequences which are substantially homologous can be identified by comparing the sequences using software known in the art or by the well-known Southern hybridization experiment.

Substantially homologous analogs and allelic variations must maintain the same biological activity as the protein they are homologous to (e.g. bind to the same receptor or ligand).

The terms "TACI/TACI-L complex" or "TACI/TACI-L interaction" are used

5   interchangeably and refer to the protein unit formed by the binding interaction of TACI to TACI-L.

The term "TACI/TACI-L fragment complex" includes the protein units formed in which at least one binding partner is either a fragment of TACI or TACI-L (e.g. the binding interaction of a TACI fragment to TACI-L, TACI to a TACI-L fragment, or a

10   TACI fragment to a TACI-L fragment) or a homologous analog of TACI or TACI-L. The TACI/TACI-L fragment complex has the same biological activity, effects, and uses as the TACI/TACI-L complex, as described below. The term "biological activity" includes the binding of TACI to TACI-L or fragments thereof.

The term "biological effects" includes any cellular changes or effects which result

15   from a protein-protein interaction or the interaction of a protein with an agonist or antagonist. Examples of a biological effect of the TACI/TACI-L complex include an increase or decrease in Ca^{2+} ions resulting from a protein-protein interaction or the activation of the transcription factors, NF-AT, AP-1 and NF_KB.

The TACI/TACI-L interaction is a protein-protein interaction. Protein-protein

20   interactions can be observed and measured in binding assays using a variety of detection methodologies that include, but are not limited to, surface plasmon resonance (Biacore), radioimmune based assays, and fluorescence polarization binding assays. When performed in the presence of a test compound, the ability of the test compound to modulate (e.g. enhance or inhibit) the protein-protein binding affinity is measured. In

25   one embodiment of the instant invention, the binding interaction between TACI and TACI-L occurs between the extracellular domain of the TACI protein and amino acids 123–285 of the extracellular domain of the TACI ligand.

The discovery of the interaction between TACI and TACI-L is described in detail in Examples 1-3. Briefly, a ligand expression construct was transfected into cells. The

30   cells were incubated with TACI:Fc, bound with an antibody of TACI:Fc, and followed by a detecting agent. A soluble form of TACI-L was used in verifying the interaction and was produced by fusing a CMV leader sequence followed by a leucine zipper motif to the polypeptide. Other useful leader sequences include IgKappa and Growth Hormone. PCR was used to amplify the cDNA sequence which encodes the extracellular domain (amino

acids 123-285) of TACI-L by using the restriction sites of specific oligonucleotides.
CMV and leucine zipper sequences can be obtained by methods well known in the art,
such as by PCR or by enzymatic digestion of previously cloned sequences. These
fragments are ligated and inserted into the appropriate expression vector. (Smith et al.,

5   *Cell*, Vol. 73, 1349-1360.)

The interaction between TACI and TACI-L was further characterized by plate
binding assays, as described in Examples 4 and 5. Plate binding assays were conducted
capturing either the TACI protein or the TACI ligand. In each instance, a high affinity
constant was obtained, demonstrating the close binding interaction between TACI and

10   TACI-L.

The discovery and understanding of the interaction between the extracellular
region of TACI and TACI-L can be used to determine potential agonists or antagonists
and to further develop understanding of which cell types TACI-L acts upon. Assays may
utilize the interaction between TACI-L and TACI to screen for potential inhibitors

15   (antagonists) or enhancers (agonists) of activity associated with TACI-L molecules and
identify candidate molecules which may serve as therapeutically active agents that
enhance, inhibit or modulate the TACI/TACI-L complex. Potential antagonists to the
TACI/TACI-L interaction may include small molecules, peptides, and antibodies that
bind to and occupy the binding site of either TACI or TACI-L, causing them to be

20   unavailable to bind to each other and therefore preventing normal biological activity.
Other potential antagonists are antisense molecules which may hybridize to mRNA *in
vivo* and block translation of the mRNA into the TACI-L protein. Potential agonists
include small molecules, peptides and antibodies which bind to TACI or TACI-L and
elicit the same or enhanced biological effects as those caused by the binding of TACI to

25   TACI-L.

Small molecules are usually less than 10K molecular weight and possess a
number of physiochemical and pharmacological properties to enhance cell penetration,
resist degradation and prolong their physiological half-lives. (Gibbs, J., Pharmaceutical
Research in Molecular Oncology, *Cell*, Vol. 79 (1994).) Antibodies, which include intact

30   molecules as well as fragments such as Fab and F(ab')2 fragments, may be used to bind
to and inhibit the TACI/TACI-L complex by blocking the commencement of the
signaling cascade. Such activity by the antibodies could be useful in the treatment of
Acute Respiratory Disease Syndrome (ARDS). (WO 98/18921 at 57.) It is preferable
that the antibodies are humanized, and more preferable that the antibodies are human.

The antibodies of the present invention may be prepared by any of a variety of well-known methods.

Antagonists may be employed to inhibit (antagonize) the interaction between TACI and TACI-L for therapeutic purposes to treat tumor and tumor metastasis and to

5   combat various autoimmune diseases that may be modulated by the TACI/TACI-L complex, e.g. multiple sclerosis and diabetes, as well as other disorders, such as viral infection, rheumatoid arthritis, graft rejection, and IgE-mediated allergic reactions. A further disorder that may be treated by antagonists of the TACI/TACI-L interaction is inflammation mediated by the interaction. In general, the interaction may be used to

10   study cellular processes associated with TNF-receptors such as immune regulation, cell proliferation, cell death, and inflammatory responses.

Specific screening methods are known in the art and many are extensively incorporated in high throughput test systems so that large numbers of test compounds can be screened within a short amount of time. The assays can be performed in a variety of

15   formats, both homogeneous and heterogeneous, and include protein-protein binding assays, biochemical screening assays, immunoassays, cell based assays, etc. These assay formats are well known in the art. (High Throughput Screening: The Discovery of Bioactive Substances, John P. Devlin (ed.), Marcel Dekker, New York, 1997, ISBN: 0-8247-0067-8; http://www.lab-robotics.org/; http://www.sbsonline.org/) The screening

20   assays of the present invention are amenable to screening of chemical libraries and are suitable for the identification of small molecule drug candidates, antibodies, peptides.

A particular example of an assay for the identification of potential TACI antagonists is a competitive assay that combines TACI-L and a candidate molecule with TACI under the appropriate conditions for a competitive assay. Either TACI or TACI-L

25   can be labeled so that the binding may be measured and the effectiveness of the antagonist judged. The label allows for detection by direct or indirect means. Direct means include, but are not limited to luminescence, radioactivity, optical or electron density. Indirect means include but are not limited to an enzyme or epitope tag.

By observing the effect that candidate molecules have on TACI/TACI-L

30   complexes in various binding assays, on TACI/TACI-L mediated activity in functional tests, and in cell based screens, molecules that are potential therapeutics because they can modulate the TACI/TACI-L-binding interaction are identified. Such molecules either mimic the biological activity of the TACI/TACI-L complex, prevent the formation of the

TACI/TACI-L complex or inhibit dissociation of the TACI/TACI-L complex already formed. Molecules preventing the interaction of TACI and TACI-L may be useful when enhancement of the immune system is desired. Antagonists of the dissociation of the TACI/TACI-L complex may be useful as immunosuppressants or antiinflammatory

5   agents.

Molecules which inhibit or prevent the dissociation of the TACI/TACI-L complex can be identified by forming the complex in the absence of a candidate molecule, then adding the candidate molecule to the mixture, and changing the conditions so that, but for the presence of the candidate molecule, TACI would be released from the complex. The

10   concentration of the free or bound TACI could then be measured and the dissociation constant of the complex could be determined and compared to a control.

Another method by which molecules which inhibit the interaction between TACI and TACI-L can be identified is the solid phase method, in which TACI is bound and placed in a medium with labeled TACI-L. After contact with a candidate molecule, the

15   amount of signal produced by the interaction between TACI and TACI-L is measured. Diminished levels of signal, in comparison to a control, indicate that the candidate molecule inhibited the interaction between TACI and TACI-L. In a further embodiment of this method, TACI-L could be bound and TACI labeled.

Yet another method by which inhibitors of the TACI/TACI-L complex are

20   identified is described in Example 7. Homogeneous assays, such as the time-resolved fluorescence energy transfer assay described in the Example, can be formatted into 96 or 384 well microtitre plates, rendering them suitable for automation using integrated robotic systems with throughputs of up to 100,000 compounds per day.

Screening assays can further be designed to find molecules that mimic the

25   biological activity of the TACI/TACI-L complex. Molecules that mimic the biological activity of the TACI/TACI-L complex may be useful for enhancing the interaction. To identify compounds for therapeutically active agents that mimic the biological activity of the TACI/TACI-L complex, it must first be determined whether a candidate molecule binds to TACI or TACI-L. A binding candidate molecule is added to a biological assay

30   to determine its biological effects. The biological effects of the candidate molecule are then compared to those of the TACI/TACI-L complex.

Thus, the present invention encompasses methods of screening candidate molecules for their ability to modulate TACI/TACI-L complexes and their ability to modulate activities mediated by TACI/TACI-L complexes. By observing the effect that

the candidate molecule has on the known binding characteristics of TACI, TACI-L or fragments thereof, compounds that inhibit or enhance TACI/TACI-L binding can be identified.

Typical candidate molecules are small molecules, antibodies, or peptides and may

5   be part of extensive small molecule libraries developed for use in screening methods. In this context, the identification of small molecules which may interact with the TACI protein or the TACI ligand can be used to develop drugs that modulate the activation pathway and may allow physicians to treat distinct immune conditions without the negative side effects present in current therapies. For such therapeutic uses, the agonists

10   or antagonists of the TACI/TACI-L complex identified can be administered through well-known means, including parenterally (subcutaneous, intramuscular, intravenous, intradermal, etc. injection) and with a suitable carrier. Formulations suitable for parenteral administration include aqueous and non-aqueous sterile injection solutions which may contain anti-oxidants, buffers, bacteriostats and solutes which render the

15   formulation instonic with the blood of the recipient; and aqueous and non-aqueous sterile suspensions which may include suspending agents or thickening agents. The dosage will depend on the specific activity of the vaccine and can be readily determined by routine experimentation.

Generally, the conditions for an assay are conditions under which TACI and

20   TACI-L would normally interact. In other words, for an assay to identify the inhibitor of the TACI//TACI-L interaction, the conditions would be such that, but for the candidate molecule, TACI and TACI-L would bind.

The following examples are offered by way of illustration, and not by way of limitation. Those skilled in the art will recognize that variations of the invention

25   embodied in the examples can be made, especially in light of the teachings of the various references cited herein, the disclosures of which are incorporated by reference in their entirety.

EXAMPLE 1

30   ## GENERATION OF TACI- FC

This Example describes a method of generating TACI-Fc. The cDNA sequence encoding the extracellular domain of TACI (amino acids 2-166) was amplified by PCR

using a sense primer (5'-ataaccggtagtggcctgggccggagcaggcgag-3') (SEQ. ID. NO. 6) and

an antisense primer (5'-ataagatctgggctcgctgtagaccagggccacctgatc) (SEQ. ID. NO. 7).

The amplified PCR fragment was digested with the appropriate restriction enzyme and

then ligated into the mammalian expression vector pDC409, in-frame with the Ig kappa

5   leader sequence at the 5' end and with the Fc portion of human IgG1 at the 3' end. The

plasmid was transfected transiently in CV1/EBNA cells and the soluble protein TACI-FC

was purified on a protein G-sepharose column. Protein concentration was determined by

BCA analysis. Purity was assessed by SDS-PAGE analysis which, under reducing

conditions, showed a single band at 42kDa.

10

EXAMPLE 2

LIGAND SCREENING BY SLIDE BINDING ASSAY

This Example describes the method of a slide binding assay and demonstrates that

15   the TACI-Fc protein interacted only with TACI-L. The purified TACI-Fc was used to

screen against a cDNA panel containing known members of the ligand family (4-1BBL,

CD40L, OX40L, CD27L, CD30L, RANKL, LT-alpha, LT-beta, LIGHT, TWEAK, FasL,

TRAIL, proTNF and TACI-L). TACI-Fc was then bound to the slides by adding 2 µg of

the DNA encoding the members of the ligand family to a sterile tube and adding 75 µM

20   choloroquine in transfection/growth medium to a final volume of 175 µl. 25 µl of

DEAE-dextran (4mg/ml in PBS) was then added to the DNA solution and mixed.

The growth medium was aspirated from the slides and replaced with 3 ml of 75

µM chloroquine in the transfection/growth medium, followed by the addition of the

DNA/DEAE-dextran mixture to the cells. The slides were rocked side-to-side and back-

25   and-forth to distribute the precipitated DNA evenly. The slides were incubated at 37°C

for 4.5 hours.

The medium was aspirated and 3 ml 10% DMSO was added in the

transfection/growth medium. After a 5 minute incubation period at room temperature,

the medium was aspirated again and replaced with 3ml fresh transfection/growth

30   medium. The cells were then incubated at 37°C for 2 days to allow for expression of the

transfected cDNAs.

To screen for positive pools expressing the cell-bound protein, slides were

incubated with TACI:Fc and then with a radioiodinated protein probe (labeled goat anti-

human Fc F(ab')2) for 30 minutes at room temperature. The probe solution is then

removed by aspiration and washed to remove the non-specifically bound probe. Finally,

the slides were fixed by incubating each slide with 1 ml 2.5% glutaraldehyde in PBS for

30 minutes at room temperature to retain specifically bound label. The slides were then

5   washed twice with 1 ml PBS and air-dried.

The dried slides were dipped in liquid photographic emulsion that has been

warmed to 42 °C, dried at room temperature and exposed for 2 days at room temperature

before developing. The slides were examined at 25 x magnification under bright-field

illumination to detect cell types upon which the ligand is acting. TACI-Fc protein was

10   found to bind only to cells transfected with the TACI-L. The ability of the TACI-FC to

bind to CV1 expressing the TACI-L was also demonstrated by the well-known methods

of flow cytometry.

EXAMPLE 3

15   IMMUNOPRECIPITATION OF
            MEMBRANE –ASSOCIATED TACI WITH THE TACI-LIGAND

This Example demonstrates the interaction between the TACI protein and TACI-

L. CV1 cells were transfected with soluble TACI-L plasmid and the two day supernatant

20   was harvested. CV1 cells were transfected with membrane associated TACI and

metabolically labeled with 35S-CYS-MET two days post-transfection (labeled cell

lysate). Supernatant containing TACI-L was used in immunoprecipitation experiments

with labeled cell lysate. A specific band at 45 kDa which was consistent with the

predicted size of TACI was obtained, as shown in Figure 1. Thus, the interaction

25   between the TACI protein and TACI-L was confirmed.

EXAMPLE 4

PLATE BINDING ASSAY CAPTURING TACI-L

30   This example further characterizes the interaction between TACI and TACI-L by

conducting a plate binding assay and demonstrates the high affinity between the proteins.

Equilibrium binding isotherms were determined in 96-well microtiter plates that had been

coated with TACI-L COS expressed supernatants, captured through Leucine Zipper M15

antibody. Plates were incubated with 5 µg/ml LZ M15 in PBS for 4 hr at 4°C. After

being washed 3 times with PBS, the plates were incubated with a 1:2 or 1:5 dilution of the COS expressing TACI supernatant in PBS/0.05% Tween 20 for 12 hours at 4°C. The plates were then washed for an additional 3 times with PBS and nonspecific binding sites were blocked with 300 μl/well of a binding media (RPMI 1640, 2.5% BSA, 20MM

5   HEPES, 0.02% sodium azide pH 7.2) and 2.5% non-fat dried milk. The plates were incubated for 1 hour at room temperature and washed 3 times with PBS.

HuTACI/Fc was diluted to 2μg/ml to the first well, and serial dilutions were performed against the binding media. Incubation occurred for 2 hours at 4°C. Plates were then washed 3 times with PBS. A final incubation occurred for 30 minutes at room

10   temperature with 125 ng/ml 125-I goat anti-human F(ab')2. The goat anti-human F(ab')2 was labeled with 125-I using solid phase chloramine T analog (Iodogen; Pierce Chemical, Rockford, IL) to a specific radioactivity of 8.73e14 cpm/mmol. Nonspecific binding was determined in the presence of 1000-fold excess of unlabeled goat anti-human F(ab')2. Plates were washed 3 times in PBS and the specifically bound ligand was

15   released with 50mM citrate (pH 3.0) and then gamma counted. Data was processed as described (Dower et al., 1984).

Figure 4a demonstrates the results of the assay using 1:2 dilution and shows the complete saturation of the receptor binding sites. Figure 4b, the Scatchard graph corresponding to Figure 4a, demonstrates the actual number of sites that were actually

20   bound. From these results, the affinity constant of 1.53×10^{-9} can be generated.

Figure 5a demonstrates the results of the assay using 1:5 dilution and shows the complete saturation of the receptor binding sites. Figure 5b, the Scatchard graph corresponding to Figure 5a, demonstrates the actual number of sites that were actually bound. From these results, the affinity constant of 2.2×10^{-9} is shown.

25

EXAMPLE 5

PLATE BINDING ASSAY CAPTURING HuTACI/FC

This example also characterizes the interaction between TACI and TACI-L by use

30   of a plate binding assay and further demonstrates the high affinity between the proteins. Equilibrium binding isotherms were determined in 96-well microtiter plates that had been coated with HuTACI/Fc, captured through goat anti-human Fc polyclonal antibody. Plates were incubated with 5 μg/ml goat anti-human FC in PBS for 4 hours at 4°C. After

being washed 3 times with PBS, the plates were incubated with 0.1 μg/ml Fc chimera in PBS/0.05% Tween 20 for 12 hours at 4°C and then washed for an additional 3 times with PBS. Nonspecific binding sites were blocked with 300 μl/well of a binding media (RPMI 1640, 2.5% BSA, 20MM HEPES, 0.02% sodium azide pH 7.2) and 2.5% non-fat dried

5   milk. The plates were incubated for 1 hour at room temperature and then washed 3 times with PBS. TACI-L was expressed in COS cells and concentrated 10-fold.

TACI-L supernatant was diluted 1:10 to the first well, and serial dilutions were performed against the binding media. Incubation occurred for 2 hours at 4°C. Plates were then washed 3 times with PBS. A final incubation occurred for 30 minutes at room

10   temperature with 125-I Leucine Zipper M15. Leucine Zipper M15 (LZM15) was labeled with 125-I using solid phase chloramine T analog (Iodogen; Pierce Chemical, Rockford, IL) to a specific radioactivity of 8.73e14 cpm/mmol. Nonspecific binding was determined in the presence of 1000-fold excess of unlabeled LZM15. Plates were washed 3 times in PBS and specifically bound ligand was released with 50mM citrate

15   (pH 3.0) and then gamma counted. Data was processed as described (Dower et al., 1984).

Figure 6a demonstrates the complete saturation of the receptor binding sites. Figure 6b, the Scatchard graph which corresponds to Figure 6a, demonstrates the actual number of sites that were actually bound. The Scatchard graph of Figure 6b

20   demonstrates a curvilinear binding, with a low affinity constant of 5.7×10^{-10} and a high affinity constant of 1.0×10^{-10}. Figure 6b demonstrates that the majority of the binding occurred at an affinity constant between $2 - 3 \times 10^{-9}$.

EXAMPLE 6

25
LIGAND SCREENING BY TIME-RESOLVED
FLUORESCENCE ENERGY TRANSFER ASSAY

This example describes a method for a homogeneous time-resolved fluorescence energy transfer (TR-FRET) assay to discover inhibitors of the TACI/TACI-L complex.

30   The TACI-L can be labeled with a Europium chelate (one of the lanthanide series fluors) according to methods well know in the art (http://www.wallac.fi/hts/post_5.pdf; Abery et al., *Optimization and validation of a homogeneous time resolved fluorescence (TRF) high throughput screening (HTS) assay for the TNFα:receptor-1 interaction*, Abstract of Papers Presented at the 3rd Annual Conference of the Society for Biomolecular

Screening, (Sep. 1997)). This fluorescence tag can be attached by a variety of chemical
conjugation methods that allow the number of chelates per molecule to be varied. The
bioactivity of the resulting conjugate can be confirmed by standard ligand binding assays
(see Example 2). For the homogeneous TR-FRET assay, 20 nM europium-labeled TACI-

5   L is incubated for 30–60 minutes with appropriate concentrations of TACI-Fc, an anti-Fc
antibody labeled with strepavidin and a biotinylated APC in a suitable neutral buffered
saline solution. Once equilibrium has been reached, if binding occurred, when the system
is excited with light at 340 nm, the europium emits light at 615 nm. This in turn excites
the APC which then emits at 665 nm (Figure 7a). The presence of an inhibitor of the

10   TACI-L:TACI-Fc binding interaction will result in a diminution of the signal at 665 nm
or in the ratio of the signals (665/ 615) (Figure 7b)

What is claimed:

1.   A method of screening a candidate molecule to identify its ability to inhibit or prevent the dissociation of a TACI/TACI-L complex, said method comprising the steps of:

   a.   forming said TACI/TACI-L complex or a TACI/TACI-L fragment complex in the absence of said candidate molecule;

   b.   adding said candidate molecule to a medium containing said TACI/TACI-L complex or said TACI/TACI-L fragment complex;

   c.   changing the conditions of said medium so that, but for the presence of said candidate molecule, said TACI or TACI fragments, would be released from the complex;

   d.   measuring the concentration of free or bound said TACI, TACI-L or fragments thereof; and

   e.   determining the dissociation constant of said TACI/TACI-L complex or said TACI/TACI-L fragment complex and comparing said constant to a dissociation constant of a TACI/TACI-L complex or TACI/TACI-L fragment complex measured in a medium not containing the candidate molecule.

2.   A method of screening a candidate molecule to identify its ability to inhibit a TACI/TACI-L complex, said method comprising the steps of:

   a.   adding TACI to a medium containing TACI-L and said candidate molecule, wherein one of either said TACI or said TACI-L is labeled and the other is bound;

   b.   measuring the level of signal produced; and

   c.   comparing the level of signal produced in step (b) to the level of signal produced by a TACI/TACI-L complex or TACI/TACI-L fragment complex formed with said labeled TACI or TACI-L in the absence of said candidate molecule;

wherein diminished levels of signal produced in step (b) indicate that said candidate molecule inhibited said TACI/TACI-L complex.

3.   A method of screening a candidate molecule to identify its ability to mimic the biological activity of the TACI/TACI-L complex, said method comprising the steps of :

a. determining if said candidate molecule binds to TACI, TACI-L or fragments thereof;

b. adding said candidate molecule to a biological assay to determine its biological effects; and

c. comparing said biological effects of said candidate molecule with the biological effects of said TACI/TACI-L complex or a TACI/TACI-L fragment complex.

4.   A method of screening a candidate molecule to identify its ability to be useful in the treatment of diseases modulated by the TACI/TACI-L complex, said method comprising the steps of:

a.   forming said TACI/TACI-L complex or a TACI/TACI-L fragment complex in the absence of said candidate molecule;

b.   adding said candidate molecule to a medium containing said TACI/TACI-L complex or said TACI/TACI-L fragment complex;

c.   changing the conditions of said medium so that, but for the presence of said candidate molecule, said TACI or TACI fragments, would be released from said TACI/TACI-L complex or said TACI/TACI-L fragment complex;

d.   measuring the concentration of free or bound said TACI, TACI-L or fragments thereof; and

e.   determining the dissociation constant of said TACI/TACI-L complex or said TACI/TACI-L fragment complex and comparing said constant to a dissociation constant of a TACI/TACI-L complex or TACI/TACI-L fragment complex measured in a medium not containing the candidate molecule.

5.   A method of screening a candidate molecule to identify its ability to be useful in the treatment of diseases modulated by the TACI/TACI-L complex, said method comprising the steps of:

a.   adding TACI to a medium containing TACI-L and said candidate

molecule, wherein one of either said TACI or said TACI-L is labeled and

the other is bound;

b.   measuring the level of signal produced; and

c.   comparing the level of signal produced in step (b) to the level of signal

produced by a TACI/TACI-L complex or TACI/TACI-L fragment

complex formed with said labeled TACI or TACI-L in the absence of said

candidate molecule.

6.   A method of screening a candidate molecule to identify its ability to be useful in

the treatment of diseases modulated by the TACI/TACI-L complex, said method

comprising the steps of:

a. determining if said candidate molecule binds to TACI or TACI-L;

b. adding said candidate molecule to a biological assay to determine its biological

effects; and

c. comparing the biological effects of said candidate molecule with the

biological effects of said TACI/TACI-L complex or a TACI/TACI-L fragment

complex.

7.   The method of any one of claims 1 through 6 in which the candidate molecule is

selected from a group consisting of a small molecule, antibody, or peptide.

8.   The method of claims 1, 3, 4 or 6, in which either TACI or TACI-L, or fragments

thereof, is labeled.

9.   The method of any one of claims 1 through 6, in which at least one fragment of

said TACI/TACI-L fragment complex is soluble.

10.   The method of any one of claims 1 through 6, in which said TACI/TACI-L

complex is comprised of the sequence of SEQ. ID. NO.:2 and the sequence of

SEQ. ID. NO.:4.

11. A method of screening a candidate molecule to identify its ability to inhibit (antagonize) or agonize a TACI/TACI-L complex, said method comprising the steps of:

    (a)   adding said candidate molecule to a medium which contains cells expressing TACI and cells expressing TACI-L;

    (b)   changing the conditions of said medium so that, but for the presence of said candidate molecule, said TACI/TACI-L complex and/or a TACI/TACI-L fragment complex would be formed;

    (c)   determining the level of biological activity of said TACI/TACI-L complex and/or said TACI/TACI-fragment complex formed in said medium; and

    (d)   comparing the level of biological activity of step (c) with the level of biological activity that occurs in said medium in the absence of said candidate molecule.

12. An antagonist as identified by the method of claim 11.

13. An agonist as identified by the method of claim 11.

14. A method of modulating an intracellular signaling cascade mediated by the TACI/TACI-L complex in a mammal comprising administering to such a mammal an effective amount of an agonist or an antagonist of the TACI/TACI-L complex.

15. A method of screening a candidate molecule to identify its ability to inhibit (antagonize) a TACI/TACI-L complex, said method comprising a high throughput screening assay, wherein diminished levels of signal produced by said assay indicate that said candidate molecule inhibited said TACI/TACI-L complex.

16. An antagonist as identified by the method of claim 15.

```
AGCATCCTGA GTAATGAGTG GCCTGGGCCG GAGCAGGCGA GGTGGCCGGA GCCGTGTGGA      60
CCAGGAGGAG CGCTTTCCAC AGGGCCTGTG GACGGGGGTG GCTATGAGAT CCTGCCCCGA     120
AGAGCAGTAC TGGGATCCTC TGCTGGGTAC CTGCATGTCC TGCAAAACCA TTTGCAACCA     180
TCAGAGCCAG CGCACCTGTG CAGCCTTCTG CAGGTCACTC AGCTGCCGCA AGGAGCAAGG     240
CAAGTTCTAT GACCATCTCC TGAGGGACTG CATCAGCTGT GCCTCCATCT GTGGACAGCA     300
CCCTAAGCAA TGTGCATACT TCTGTGAGAA CAAGCTCAGG AGCCCAGTGA ACCTTCCACC     360
AGAGCTCAGG AGACAGCGGA GTGGAGAAGT TGAAAACAAT TCAGACAACT CGGGAAGGTA     420
CCAAGGATTG GAGCACAGAG GCTCAGAAGC AAGTCCAGCT CTCCCGGGGC TGAAGCTGAG     480
TGCAGATCAG GTGGCCCTGG TCTACAGCAC GCTGGGGCTC TGCCTGTGTG CCGTCCTCTG     540
CTGCTTCCTG GTGGCGGTGG CCTGCTTCCT CAAGAAGAGG GGGGATCCCT GCTCCTGCCA     600
GCCCCGCTCA AGGCCCCGTC AAAGTCCGGC CAAGTCTTCC CAGGATCACG CGATGGAAGC     660
CGGCAGCCCT GTGAGCACAT CCCCCGAGCC AGTGGAGACC TGCAGCTTCT GCTTCCCTGA     720
GTGCAGGGCG CCCACGCAGG AGAGCGCAGT CACGCCTGGG ACCCCCGACC CCACTTGTGC     780
TGGAAGGTGG GGGTGCCACA CCAGGACCAC AGTCCTGCAG CCTTGCCCAC ACATCCCAGA     840
CAGTGGCCTT GGCATTGTGT GTGTGCCTGC CCAGGAGGGG GGCCCAGGTG CATAAATGGG     900
GGTCAGGGAG GGAAAGGAGG AGGGAGAGAG ATGGAGAGGA GGGGAGAGAG AAAGAGAGGT     960
GGGGAGAGGG GAGAGAGATA TGAGGAGAGA GAGACAGAGG AGGCAGAAAG GGAGAGAAAC    1020
AGAGGAGACA GAGAGGGAGA GAGAGACAGA GGGAGAGAGA GACAGAGGGG AAGAGAGGCA    1080
GAGAGGGAAA GAGGCAGAGA AGGAAAGAGA CAGGCAGAGA AGGAGAGAGG CAGAGAGGGA    1140
GAGAGGCAGA GAGGGAGAGA GGCAGAGAGA CAGAGAGGGA GAGAGGGACA GAGAGAGATA    1200
GAGCAGGAGG TCGGGGCACT CTGAGTCCCA GTTCCCAGTG CAGCTGTAGG TCGTCATCAC    1260
CTAACCACAC GTGCAATAAA GTCCTCGTGC CTGCTGCTCA CAGCCCCCGA GAGCCCCTCC    1320
TCCTGGAGAA TAAAACCTTT GGCAGCTGCC CTTCCTCAAA AAAAAAAAAA AAAAAAA      1377
```

FIGURE 1A

```
Met Ser Gly Leu Gly Arg Ser Arg Arg Gly Gly Arg Ser Arg Val Asp
1               5                    10                   15

Gln Glu Glu Arg Phe Pro Gln Gly Leu Trp Thr Gly Val Ala Met Arg
              20                  25                  30

Ser Cys Pro Glu Glu Gln Tyr Trp Asp Pro Leu Leu Gly Thr Cys Met
          35                  40                  45

Ser Cys Lys Thr Ile Cys Asn His Gln Ser Gln Arg Thr Cys Ala Ala
      50                  55                  60

Phe Cys Arg Ser Leu Ser Cys Arg Lys Glu Gln Gly Lys Phe Tyr Asp
65              70                  75                  80

His Leu Leu Arg Asp Cys Ile Ser Cys Ala Ser Ile Cys Gly Gln His
              85                  90                  95

Pro Lys Gln Cys Ala Tyr Phe Cys Glu Asn Lys Leu Arg Ser Pro Val
              100                 105                 110

Asn Leu Pro Pro Glu Leu Arg Arg Gln Arg Ser Gly Glu Val Glu Asn
          115                 120                 125

Asn Ser Asp Asn Ser Gly Arg Tyr Gln Gly Leu Glu His Arg Gly Ser
      130                 135                 140

Glu Ala Ser Pro Ala Leu Pro Gly Leu Lys Leu Ser Ala Asp Gln Val
145                 150                 155                 160

Ala Leu Val Tyr Ser Thr Leu Gly Leu Cys Leu Cys Ala Val Leu Cys
              165                 170                 175

Cys Phe Leu Val Ala Val Ala Cys Phe Leu Lys Lys Arg Gly Asp Pro
              180                 185                 190

Cys Ser Cys Gln Pro Arg Ser Arg Pro Arg Gln Ser Pro Ala Lys Ser
          195                 200                 205

Ser Gln Asp His Ala Met Glu Ala Gly Ser Pro Val Ser Thr Ser Pro
      210                 215                 220

Glu Pro Val Glu Thr Cys Ser Phe Cys Phe Pro Glu Cys Arg Ala Pro
225                 230                 235                 240

Thr Gln Glu Ser Ala Val Thr Pro Gly Thr Pro Asp Pro Thr Cys Ala
              245                 250                 255

Gly Arg Trp Gly Cys His Thr Arg Thr Thr Val Leu Gln Pro Cys Pro
              260                 265                 270

His Ile Pro Asp Ser Gly Leu Gly Ile Val Cys Val Pro Ala Gln Glu
          275                 280                 285

Gly Gly Pro Gly Ala
          290
```

FIGURE 1B

(start and stop codons are in bold type)

```
AGCAAGTTCA GCCTGGTTAA GTCCAAGCTG AATTCCGGTC AAAGTTCAAG
TAGTGATATG GATGACTCCA CAGAAAGGGA GCAGTCACGC CTTACTTCTT
GCCTTAAGAA AAGAGAAGAA ATGAAACTGA AGGAGTGTGT TTCCATCCTC
CCACGGAAGG AAAGCCCCTC TGTCCGATCC TCCAAAGACG GAAAGCTGCT
GGCTGCAACC TTGCTGCTGG CACTGCTGTC TTGCTGCCTC ACGGTGGTGT
CTTTCTACCA GGTGGCCGCC CTGCAAGGGG ACCTGGCCAG CCTCCGGGCA
GAGCTGCAGG GCCACCACGC GGAGAAGCTG CCAGCAGGAG CAGGAGCCCC
CAAGGCCGGC CTGGAGGAAG CTCCAGCTGT CACCGCGGGA CTGAAAATCT
TTGAACCACC AGCTCCAGGA GAAGGCAACT CCAGTCAGAA CAGCAGAAAT
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ACTGATTGCA GACAGTGAAA CACCAACTAT ACAAAAAGGA TCTTACACAT
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GAGAATAAAA TATTGGTCAA AGAAACTGGT TACTTTTTTA TATATGGTCA
GGTTTTATAT ACTGATAAGA CCTACGCCAT GGGACATCTA ATTCAGAGGA
AGAAGGTCCA TGTCTTTGGG GATGAATTGA GTCTGGTGAC TTTGTTTCGA
TGTATTCAAA ATATGCCTGA AACACTACCC AATAATTCCT GCTATTCAGC
TGGCATTGCA AAACTGGAAG AAGGAGATGA ACTCCAACTT GCAATACCAA
GAGAAAATGC ACAAATATCA CTGGATGGAG ATGTCACATT TTTTGGTGCA
TTGAAACTGC TGTGACCTAC TTACACCATG TCTGTAGCTA TTTTCCTCCC
TTTCTCTGTA CCTCTAAGAA GAAAGAATCT AACTGAAAAT ACCAAAAAAA
AAAAAAAAAA AAAAGATCT TTAATTAAGC GGCCGCAAGC TTATTCCCTT
TAGTGAG
```

FIGURE 2A

Translation in relevant reading frame (3' 5'):

```
MDDSTEREQS RLTSCLKKRE EMKLKECVSI LPRKESPSVR SSKDGKLLAA
TLLLALLSCC LTVVSFYQVA ALQGDLASLR AELQGHHAEK LPAGAGAPKA
GLEEAPAVTA GLKIFEPPAP GEGNSSQNSR NKRAVQGPEE TVTQDCLQLI
ADSETPTIQK GSYTFVPWLL SFKRGSALEE KENKILVKET GYFFIYGQVL
YTDKTYAMGH LIQRKKVHVF GDELSLVTLF RCIQNMPETL PNNSCYSAGI
AKLEEGDELQ LAIPRENAQI SLDGDVTFFG ALKLL
```

FIGURE 2B

Translation in relevant reading frame (3' 5'):

```
MARRLWILSL LAVTLTVALA APSQKSKRRT SSDRMKQIED KIEEILSKIY
HIENEIARIK KLIGERTRSG NSSQNSRNKR AVQGPEETVT QDCLQLIADS
ETPTIQKGSY TFVPWLLSFK RGSALEEKEN KILVKETGYF FIYGQVLYTD
KTYAMGHLIQ RKKVHVFGDE LSLVTLFRCI QNMPETLPNN SCYSAGIAKL
EEGDELQLAI PRENAQISLD GDVTFFGALK LL
(SEQ ID NO:3)
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FIGURE 3
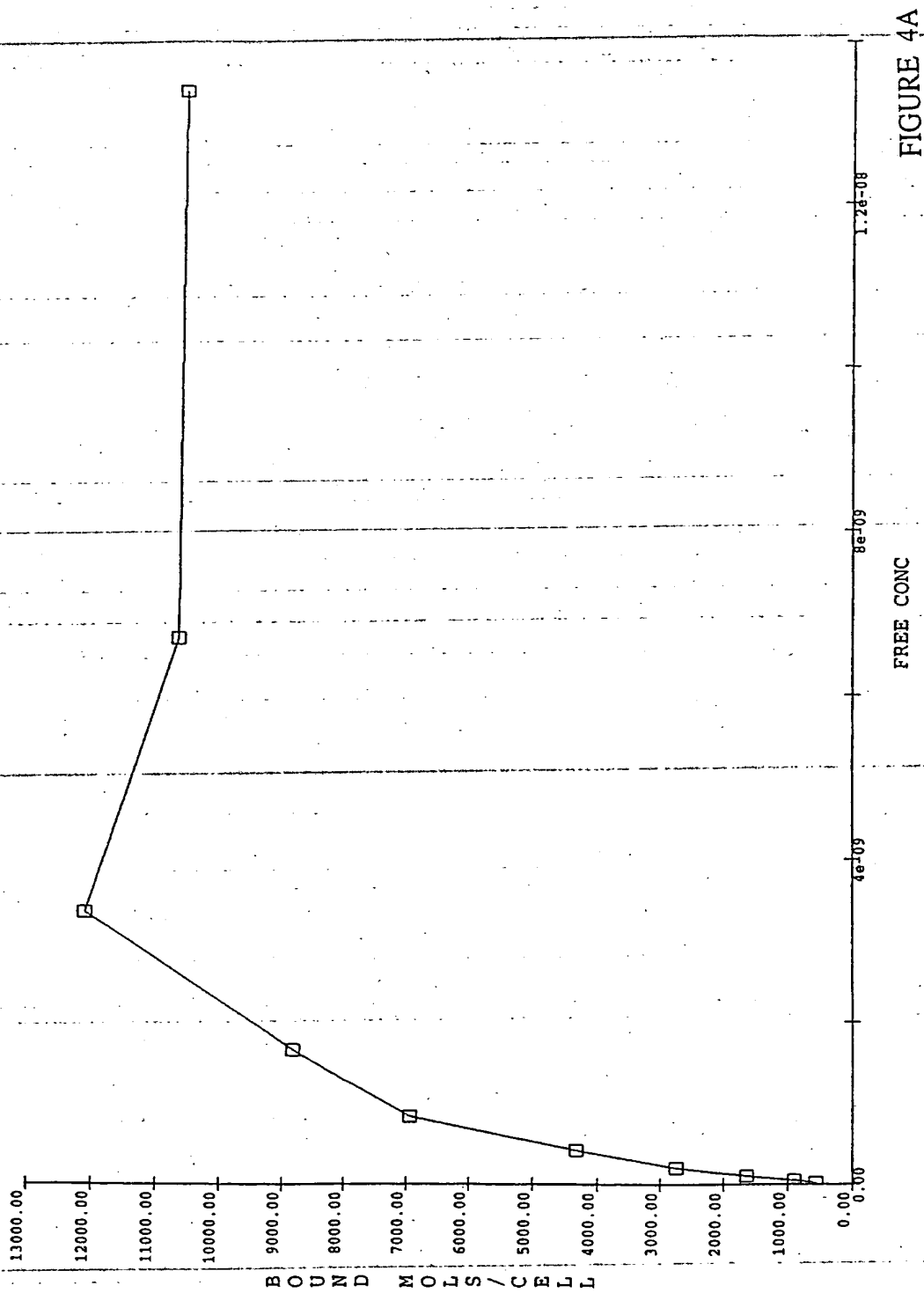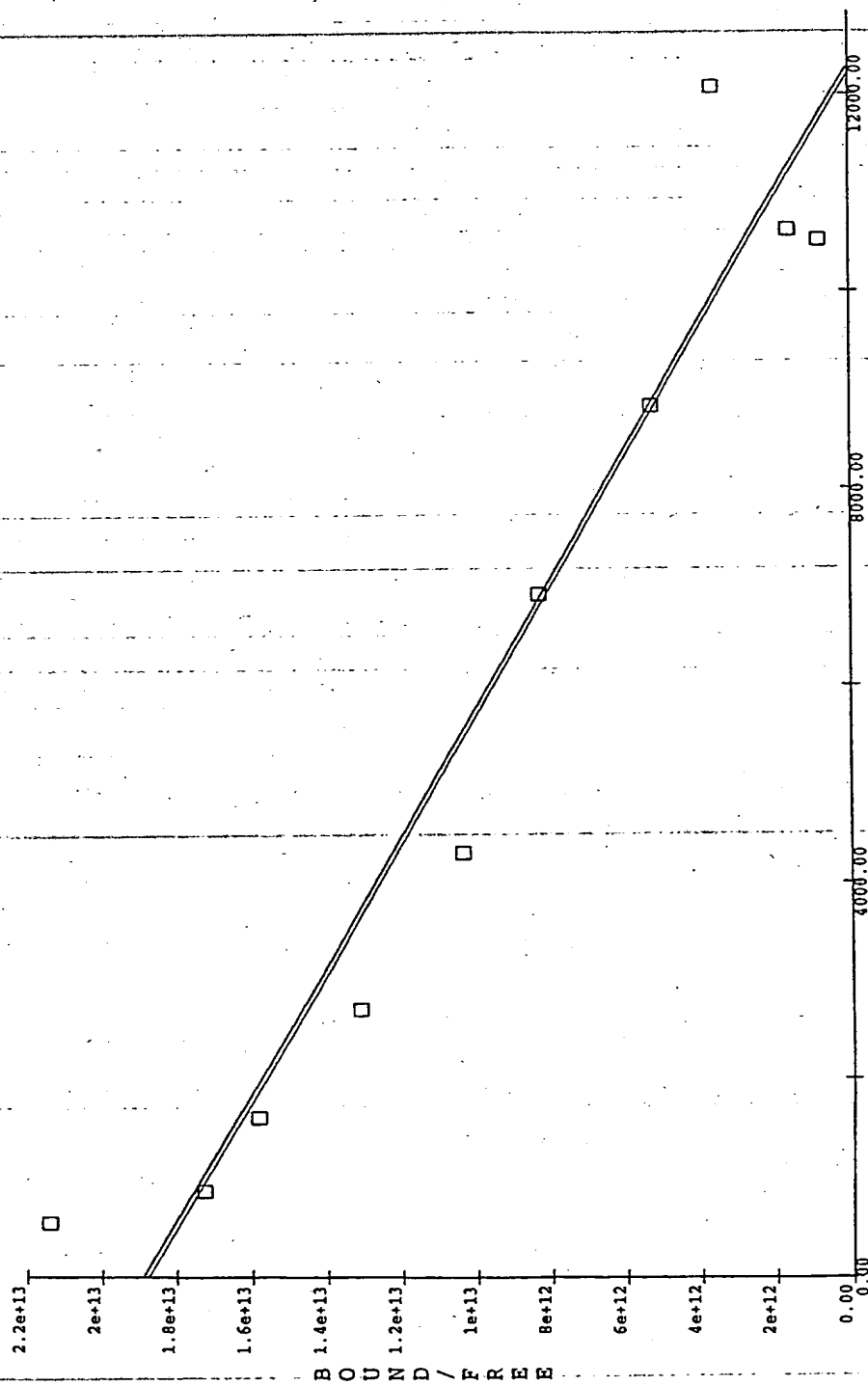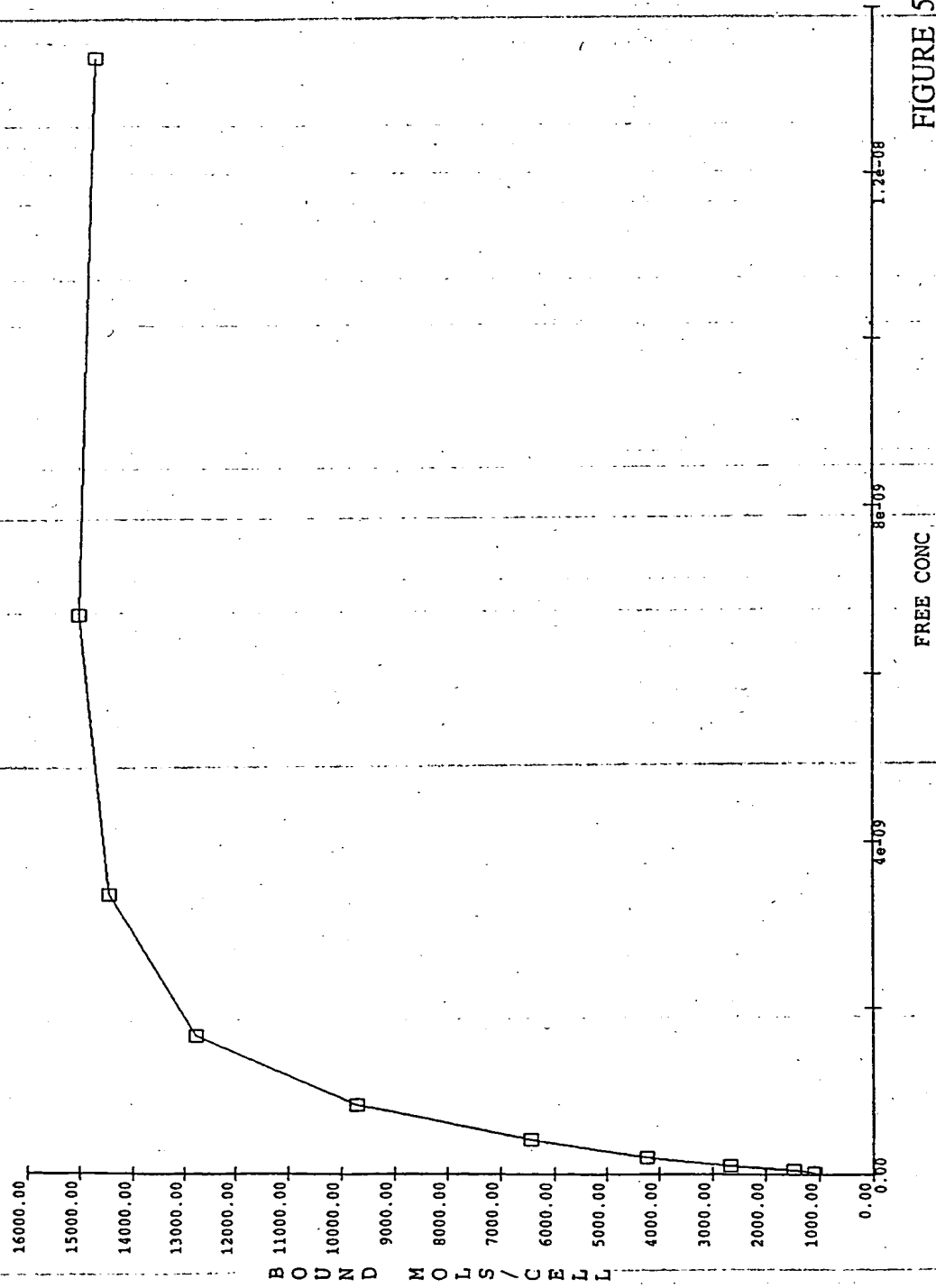
FIGURE 4A

FIGURE 4B

FIGURE 5A

FIGURE 5B

FIGURE 6A

O   Data points
(2.1e+03*5.7e+08*X)/(1+5.7e+08*X)+(1.9e+03*1.0e+10*X)/(1+1.0e+10*X)

FIGURE 6B

FIGURE 7

FIG. 7a

1 Eu: 1 TACI-L

FIG. 7b

Small molecule inhibitor
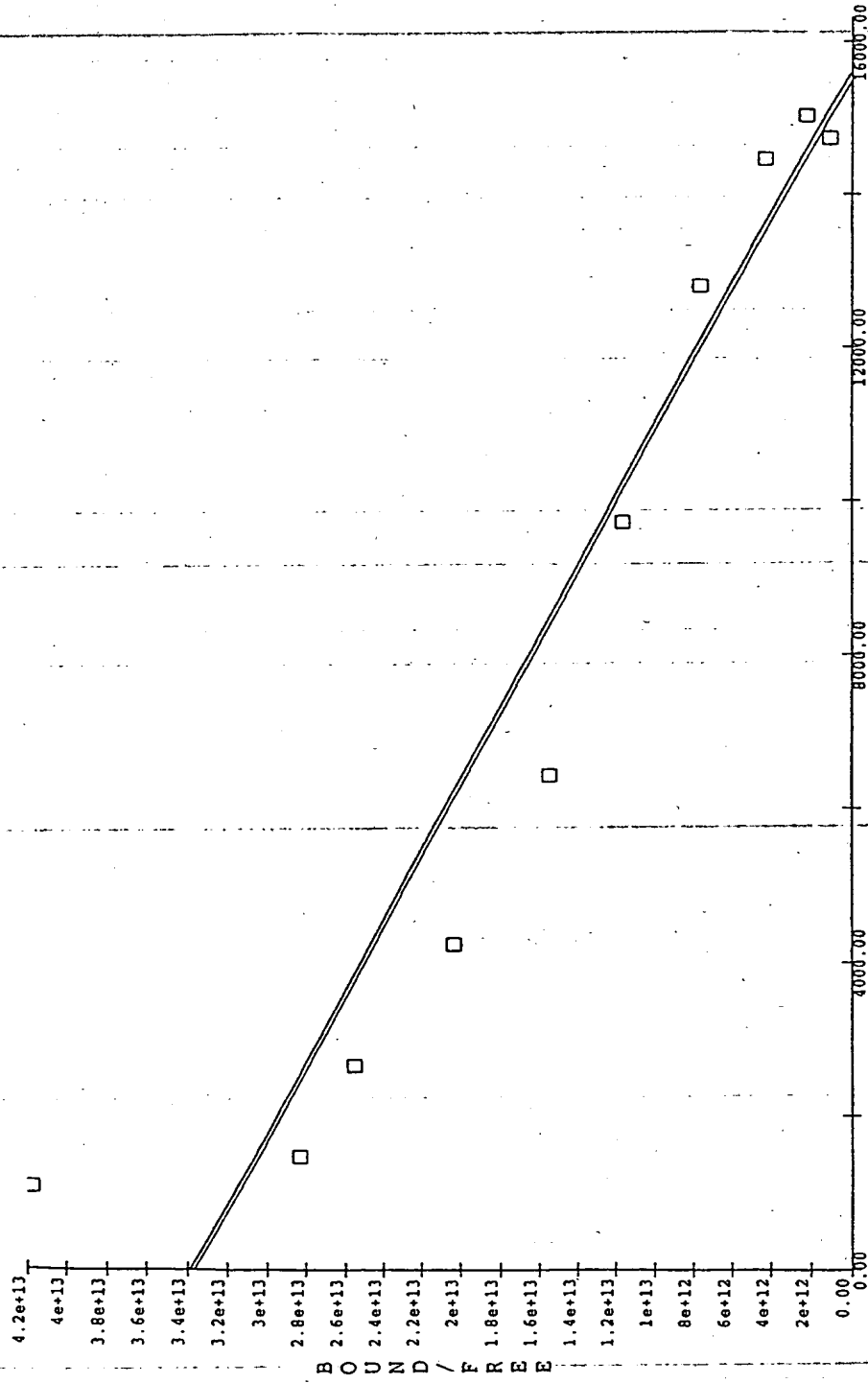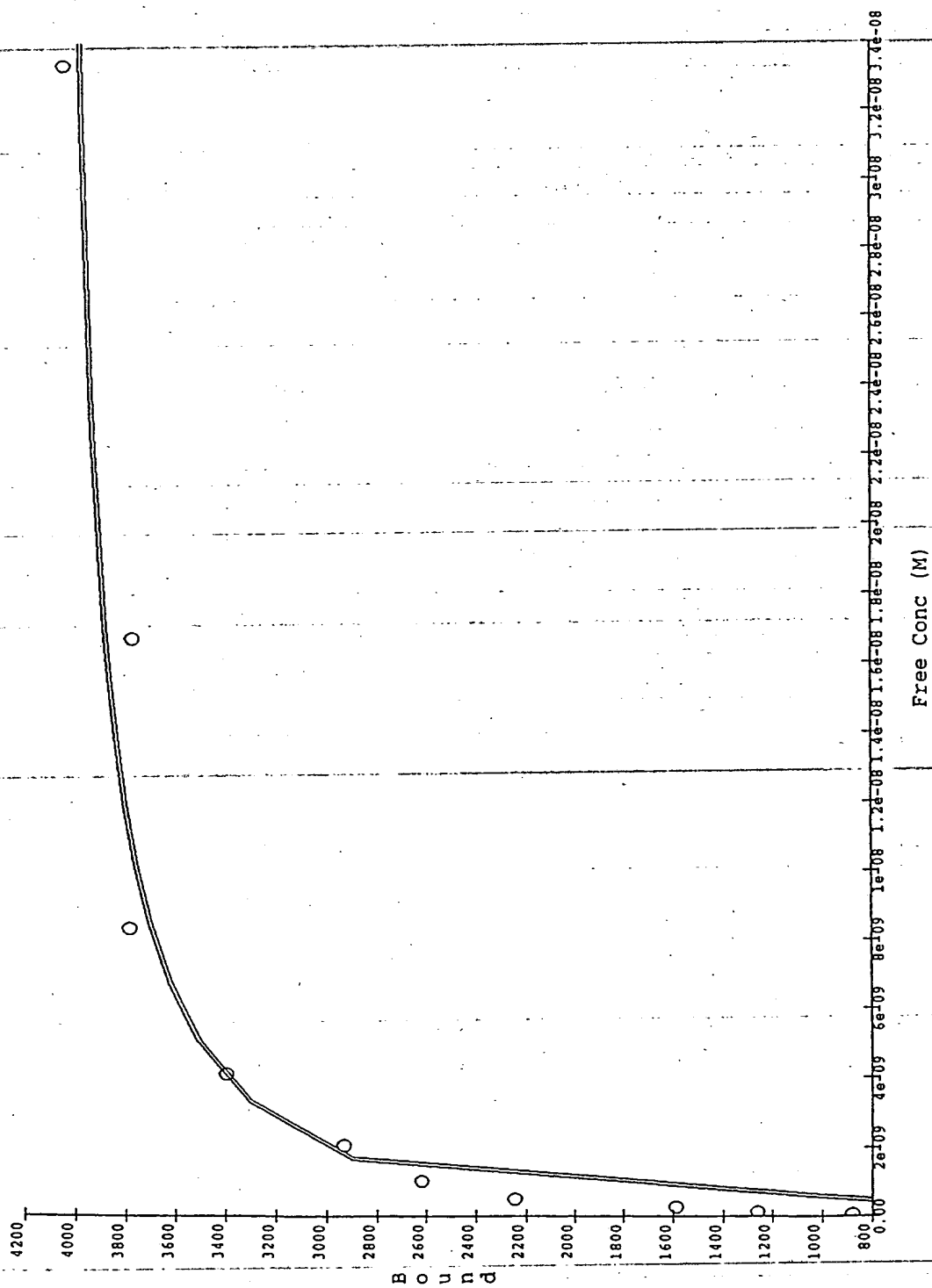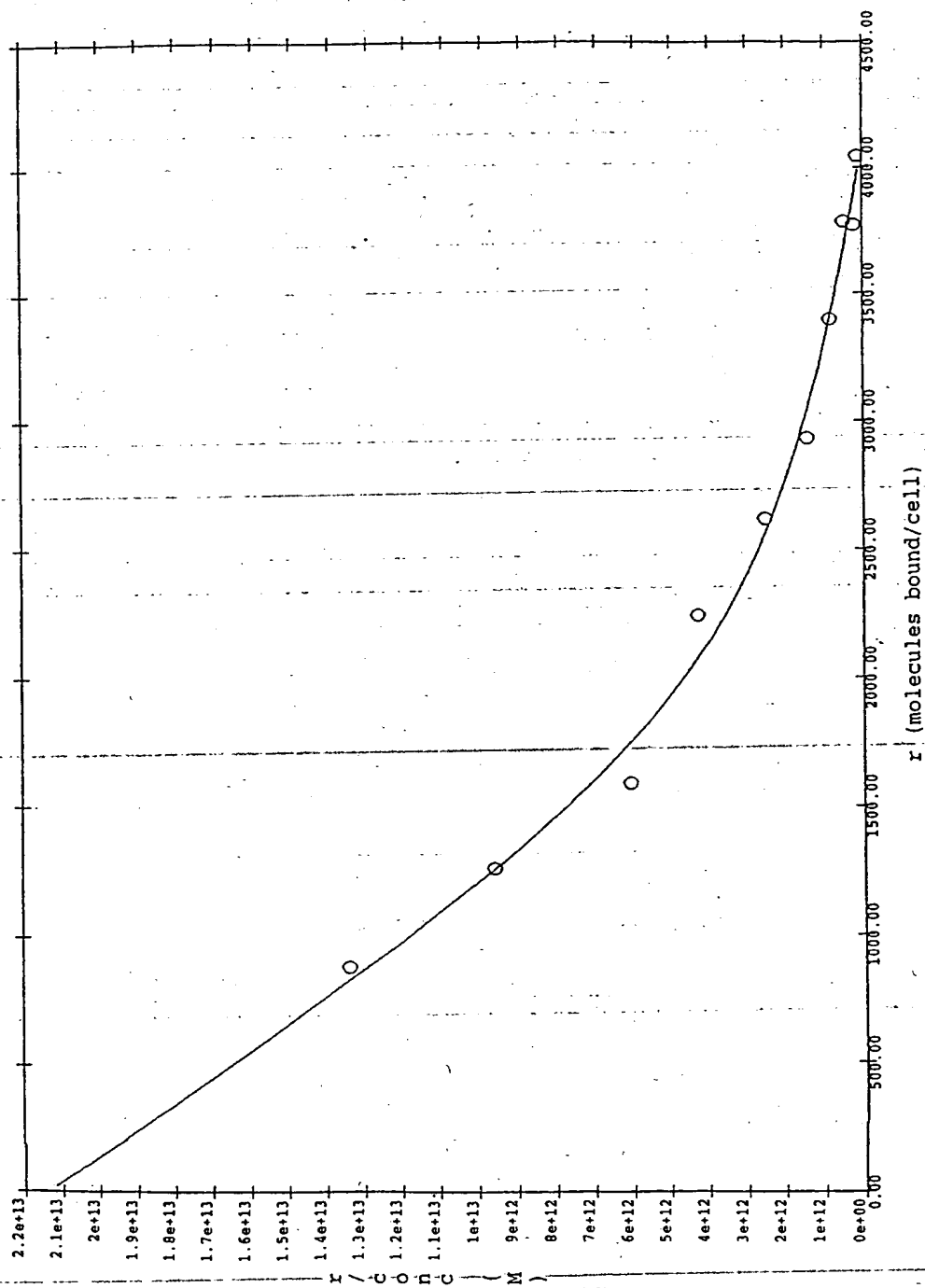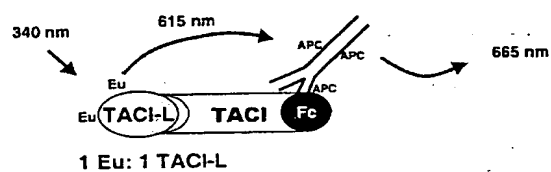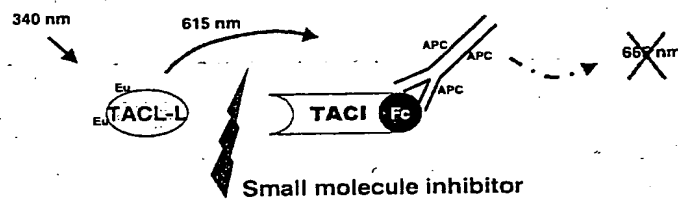
SEQUENCE LISTING

<110> Immunex Corporation
      Goodwin, Raymond G.
      Din, Wanwan S.

<120> METHODS OF USE OF THE TACI/TACI-L INTERACTION

<130> 2519-WO

<140> --to be assigned--
<141> 2000-04-14

<150> 09/302,863
<151> 1999-04-30

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            1   5   10

agc cgt gtg gac cag gag gag cgc ttt cca cag ggc ctg tgg acg ggg   97
Ser Arg Val Asp Gln Glu Glu Arg Phe Pro Gln Gly Leu Trp Thr Gly
        15   20   25

gtg gct atg aga tcc tgc ccc gaa gag cag tac tgg gat cct ctg ctg   145
Val Ala Met Arg Ser Cys Pro Glu Glu Gln Tyr Trp Asp Pro Leu Leu
    30   35   40

ggt acc tgc atg tcc tgc aaa acc att tgc aac cat cag agc cag cgc   193
Gly Thr Cys Met Ser Cys Lys Thr Ile Cys Asn His Gln Ser Gln Arg
45   50   55   60

acc tgt gca gcc ttc tgc agg tca ctc agc tgc cgc aag gag caa ggc   241
Thr Cys Ala Ala Phe Cys Arg Ser Leu Ser Cys Arg Lys Glu Gln Gly
                65   70   75

aag ttc tat gac cat ctc ctg agg gac tgc atc agc tgt gcc tcc atc   289
Lys Phe Tyr Asp His Leu Leu Arg Asp Cys Ile Ser Cys Ala Ser Ile
                80   85   90

tgt gga cag cac cct aag caa tgt gca tac ttc tgt gag aac aag ctc   337
Cys Gly Gln His Pro Lys Gln Cys Ala Tyr Phe Cys Glu Asn Lys Leu
            95   100   105

```
agg agc cca gtg aac ctt cca cca gag ctc agg aga cag cgg agt gga    385
Arg Ser Pro Val Asn Leu Pro Pro Glu Leu Arg Arg Gln Arg Ser Gly
    110             115              120

gaa gtt gaa aac aat tca gac aac tcg gga agg tac caa gga ttg gag    433
Glu Val Glu Asn Asn Ser Asp Asn Ser Gly Arg Tyr Gln Gly Leu Glu
125             130              135              140

cac aga ggc tca gaa gca agt cca gct ctc ccg ggg ctg aag ctg agt    481
His Arg Gly Ser Glu Ala Ser Pro Ala Leu Pro Gly Leu Lys Leu Ser
            145              150              155

gca gat cag gtg gcc ctg gtc tac agc acg ctg ggg ctc tgc ctg tgt    529
Ala Asp Gln Val Ala Leu Val Tyr Ser Thr Leu Gly Leu Cys Leu Cys
            160              165              170

gcc gtc ctc tgc tgc ttc ctg gtg gcg gtg gcc tgc ttc ctc aag aag    577
Ala Val Leu Cys Cys Phe Leu Val Ala Val Ala Cys Phe Leu Lys Lys
            175              180              185

agg ggg gat ccc tgc tcc tgc cag ccc cgc tca agg ccc cgt caa agt    625
Arg Gly Asp Pro Cys Ser Cys Gln Pro Arg Ser Arg Pro Arg Gln Ser
    190              195              200

ccg gcc aag tct tcc cag gat cac gcg atg gaa gcc ggc agc cct gtg    673
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205              210              215              220

agc aca tcc ccc gag cca gtg gag acc tgc agc ttc tgc ttc cct gag    721
Ser Thr Ser Pro Glu Pro Val Glu Thr Cys Ser Phe Cys Phe Pro Glu
                225              230              235

tgc agg gcg ccc acg cag gag agc gca gtc acg cct ggg acc ccc gac    769
Cys Arg Ala Pro Thr Gln Glu Ser Ala Val Thr Pro Gly Thr Pro Asp
            240              245              250

ccc act tgt gct gga agg tgg ggg tgc cac acc agg acc aca gtc ctg    817
Pro Thr Cys Ala Gly Arg Trp Gly Cys His Thr Arg Thr Thr Val Leu
            255              260              265

cag cct tgc cca cac atc cca gac agt ggc ctt ggc att gtg tgt gtg    865
Gln Pro Cys Pro His Ile Pro Asp Ser Gly Leu Gly Ile Val Cys Val
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cct gcc cag gag ggg ggc cca ggt gca taaatggggg tcagggaggg         912
Pro Ala Gln Glu Gly Gly Pro Gly Ala
285              290

aaaggaggag ggagagagat ggagaggagg ggagagagaa agagaggtgg ggagagggga  972

gagagatatg aggagagaga gacagaggag gcagaaaggg agagaaacag aggagacaga  1032

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Ser Cys Lys Thr Ile Cys Asn His Gln Ser Gln Arg Thr Cys Ala Ala
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Phe Cys Arg Ser Leu Ser Cys Arg Lys Glu Gln Gly Lys Phe Tyr Asp
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His Leu Leu Arg Asp Cys Ile Ser Cys Ala Ser Ile Cys Gly Gln His
            85   90   95

Pro Lys Gln Cys Ala Tyr Phe Cys Glu Asn Lys Leu Arg Ser Pro Val
            100   105   110

Asn Leu Pro Pro Glu Leu Arg Arg Gln Arg Ser Gly Glu Val Glu Asn
        115   120   125

Asn Ser Asp Asn Ser Gly Arg Tyr Gln Gly Leu Glu His Arg Gly Ser
    130   135   140

Glu Ala Ser Pro Ala Leu Pro Gly Leu Lys Leu Ser Ala Asp Gln Val
145   150   155   160

Ala Leu Val Tyr Ser Thr Leu Gly Leu Cys Leu Cys Ala Val Leu Cys
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Cys Phe Leu Val Ala Val Ala Cys Phe Leu Lys Lys Arg Gly Asp Pro
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Cys Ser Cys Gln Pro Arg Ser Arg Pro Arg Gln Ser Pro Ala Lys Ser
        195   200   205

Ser Gln Asp His Ala Met Glu Ala Gly Ser Pro Val Ser Thr Ser Pro
    210   215   220

Glu Pro Val Glu Thr Cys Ser Phe Cys Phe Pro Glu Cys Arg Ala Pro
225   230   235   240

Thr Gln Glu Ser Ala Val Thr Pro Gly Thr Pro Asp Pro Thr Cys Ala
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aag aaa aga gaa gaa atg aaa ctg aag gag tgt gtt tcc atc ctc cca        153
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cgg aag gaa agc ccc tct gtc cga tcc tcc aaa gac gga aag ctg ctg        201
Arg Lys Glu Ser Pro Ser Val Arg Ser Ser Lys Asp Gly Lys Leu Leu
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Ala Ala Thr Leu Leu Leu Ala Leu Leu Ser Cys Cys Leu Thr Val Val
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gca gag ctg cag ggc cac cac gcg gag aag ctg cca gca gga gca gga        345
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gcc ccc aag gcc ggc ctg gag gaa gct cca gct gtc acc gcg gga ctg        393
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            100                 105                 110

aaa atc ttt gaa cca cca gct cca gga gaa ggc aac tcc agt cag aac        441
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agc aga aat aag cgt gcc gtt cag ggt cca gaa gaa aca gtc act caa        489
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4

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Gly Ser Tyr Thr Phe Val Pro Trp Leu Leu Ser Phe Lys Arg Gly Ser
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gcc cta gaa gaa aaa gag aat aaa ata ttg gtc aaa gaa act ggt tac   633
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            180                 185                 190

ttt ttt ata tat ggt cag gtt tta tat act gat aag acc tac gcc atg   681
Phe Phe Ile Tyr Gly Gln Val Leu Tyr Thr Asp Lys Thr Tyr Ala Met
            195                 200                 205

gga cat cta att cag agg aag aag gtc cat gtc ttt ggg gat gaa ttg   729
Gly His Leu Ile Gln Arg Lys Lys Val His Val Phe Gly Asp Glu Leu
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Ser Leu Val Thr Leu Phe Arg Cys Ile Gln Asn Met Pro Glu Thr Leu
225                 230                 235                 240

ccc aat aat tcc tgc tat tca gct ggc att gca aaa ctg gaa gaa gga   825
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                245                 250                 255

gat gaa ctc caa ctt gca ata cca aga gaa aat gca caa ata tca ctg   873
Asp Glu Leu Gln Leu Ala Ile Pro Arg Glu Asn Ala Gln Ile Ser Leu
            260                 265                 270

gat gga gat gtc aca ttt ttt ggt gca ttg aaa ctg ctg tgacctactt   922
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        275                 280                 285

acaccatgtc tgtagctatt ttcctccctt tctctgtacc tctaagaaga aagaatctaa 982

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Arg Lys Glu Ser Pro Ser Val Arg Ser Ser Lys Asp Gly Lys Leu Leu
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            85               90               95

Ala Pro Lys Ala Gly Leu Glu Glu Ala Pro Ala Val Thr Ala Gly Leu
           100              105              110

Lys Ile Phe Glu Pro Pro Ala Pro Gly Glu Gly Asn Ser Ser Gln Asn
         115              120              125

Ser Arg Asn Lys Arg Ala Val Gln Gly Pro Glu Glu Thr Val Thr Gln
      130              135              140

Asp Cys Leu Gln Leu Ile Ala Asp Ser Glu Thr Pro Thr Ile Gln Lys
145              150              155              160

Gly Ser Tyr Thr Phe Val Pro Trp Leu Leu Ser Phe Lys Arg Gly Ser
             165              170              175

Ala Leu Glu Glu Lys Glu Asn Lys Ile Leu Val Lys Glu Thr Gly Tyr
          180              185              190

Phe Phe Ile Tyr Gly Gln Val Leu Tyr Thr Asp Lys Thr Tyr Ala Met
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Gly His Leu Ile Gln Arg Lys Lys Val His Val Phe Gly Asp Glu Leu
    210              215              220

Ser Leu Val Thr Leu Phe Arg Cys Ile Gln Asn Met Pro Glu Thr Leu
225              230              235              240

Pro Asn Asn Ser Cys Tyr Ser Ala Gly Ile Ala Lys Leu Glu Glu Gly
             245              250              255

Asp Glu Leu Gln Leu Ala Ile Pro Arg Glu Asn Ala Gln Ile Ser Leu
         260              265              270

Asp Gly Asp Val Thr Phe Phe Gly Ala Leu Lys Leu Leu
         275              280              285


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Arg Met Lys Gln Ile Glu Asp Lys Ile Glu Glu Ile Leu Ser Lys Ile
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Tyr His Ile Glu Asn Glu Ile Ala Arg Ile Lys Lys Leu Ile Gly Glu
    50               55               60
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Arg Thr Arg Ser Gly Asn Ser Ser Gln Asn Ser Arg Asn Lys Arg Ala
65   70   75   80

Val Gln Gly Pro Glu Glu Thr Val Thr Gln Asp Cys Leu Gln Leu Ile
                  85   90   95

Ala Asp Ser Glu Thr Pro Thr Ile Gln Lys Gly Ser Tyr Thr Phe Val
              100   105   110

Pro Trp Leu Leu Ser Phe Lys Arg Gly Ser Ala Leu Glu Glu Lys Glu
          115   120   125

Asn Lys Ile Leu Val Lys Glu Thr Gly Tyr Phe Phe Ile Tyr Gly Gln
      130   135   140

Val Leu Tyr Thr Asp Lys Thr Tyr Ala Met Gly His Leu Ile Gln Arg
145   150   155   160

Lys Lys Val His Val Phe Gly Asp Glu Leu Ser Leu Val Thr Leu Phe
              165   170   175

Arg Ile Cys Ile Gln Asn Met Pro Glu Thr Leu Pro Asn Asn Ser Cys
          180   185   190

Tyr Ser Ala Gly Ile Ala Lys Leu Glu Glu Gly Asp Glu Leu Gln Leu
      195   200   205

Ala Thr Pro Arg Glu Asn Ala Gln Ile Ser Leu Asp Gly Asp Val Thr
210   215   220

Phe Phe Gly Ala Leu Lys Leu Leu
225   230

2519

1

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7   G01N33/68   G01N33/566

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7   G01N   C07K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, BIOSIS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category°	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
E	WO 00 40716 A (ZYMOGENETICS INC) 13 July 2000 (2000-07-13) claims 29,37-55 page 2, line 7 - line 12 page 4, line 35 -page 6, line 6 page 12, line 29 -page 13, line 10 page 55, line 29 -page 57, line 20 page 59, line 24 - line 33	1-16
X	EP 0 869 180 A (SMITHKLINE BEECHAM CORP) 7 October 1998 (1998-10-07) cited in the application page 2, line 14 - line 49 page 13, line 45 - line 56	1-16
	-/--	

[X] Further documents are listed in the continuation of box C.   [X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 September 2000	19/09/2000

Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Routledge, B

Inte   onal Application No
PCT/US 00/10282

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	WO 98 39361 A (ST JUDE CHILDRENS RES HOSPITAL) 11 September 1998 (1998-09-11) cited in the application claims page 4, line 33 -page 5, line 3 page 10, line 3 -page 11, line 2 page 16, line 24 -page 17, line 2 page 52, line 19 - line 27	1-16
X	WO 98 27114 A (SCHERING CORP) 25 June 1998 (1998-06-25) cited in the application page 3, line 7 - line 9 page 17, line 13 - line 17 page 26, line 14 - line 27 page 37, line 32 -page 38, line 27 page 47, line 6 - line 17 page 52, line 29 -page 53, line 12	1-16
X	WO 98 18921 A (HUMAN GENOME SCIENCES INC ;NI JIAN (US); EBNER REINHARD (US); YU G) 7 May 1998 (1998-05-07) cited in the application page 12, line 1 -page 13, line 13 page 54, line 1 -page 57, line 28	1-16

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box I.2

Claims Nos.: 12, 13, 16

Present claims 12, 13 and 16 relate to an extremely large number of
possible compounds. Support within the meaning of Article 6 PCT and
disclosure within the meaning of Article 5 PCT is so lacking (merely
general statements e.g. page 9 lines 11-25, no specific examples are
given) that a meaningful search over the whole of the claimed scope is
impossible. Consequently, the search has been limited to the
identification of documents relating to the TACI/TACI-L binding
interaction.

The applicant's attention is drawn to the fact that claims, or parts of
claims, relating to inventions in respect of which no international
search report has been established need not be the subject of an
international preliminary examination (Rule 66.1(e) PCT). The applicant
is advised that the EPO policy when acting as an International
Preliminary Examining Authority is normally not to carry out a
preliminary examination on matter which has not been searched. This is
the case irrespective of whether or not the claims are amended following
receipt of the search report or during any Chapter II procedure.

INTERNATIONAL SEARCH REPORT

Information on patent family members

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
WO 0040716	A	13-07-2000	NONE		
EP 0869180	A	07-10-1998	CA	2232743 A	02-10-1998
			JP	10323194 A	08-12-1998
			JP	2000060580 A	29-02-2000
WO 9839361	A	11-09-1998	US	5969102 A	19-10-1999
			AU	6685498 A	22-09-1998
			EP	0964874 A	22-12-1999
WO 9827114	A	25-06-1998	AU	5705898 A	15-07-1998
WO 9818921	A	07-05-1998	AU	7674596 A	22-05-1998
			BR	9612752 A	18-01-2000
			EP	0939804 A	08-09-1999